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THE INFLUENCE OF LIGHT ON ESTABLISHMENT AND GROWTH OF DWARFMISTLETOE ON PONDEROSA AND JEFFREY PINES

By

Willis W. Wagener, Plant Pathologist 1/
Division of Forest Disease Research

A long-held opinion, apparently based on field observations, is that the growth and development of dwarfmistletoes of the genus Arceuthobium is favored by abundant light. Weir (1916), on the basis that dwarfmistletoes are light-loving plants, advocated the maintenance of fairly dense coniferous stands where the parasite was present. In discussing infected, isolated seed trees, Weir stated "The vigor of the parasite on the parent tree will become greater, owing to its response to open and well lighted conditions." Korstian and Long (1922), in discussing the effects of climate on dwarfmistletoe in ponderosa pine on the Colorado Plateau in Arizona, offered their opinion that "the great amount of sunshine is favorable to the parasite." Gill (1935), in his monographic treatment of dwarfmistletoes of the United States stated "The shoots seem to respond in vigor and abundance directly to the amount of light."

From experiments with seeds of Arceuthobium oxycedri from juniper, Heinricher (1915, 1917) in Austria concluded that light was necessary for germination of seeds of the parasite, but he did not determine how much was needed for optimum effect. Weir (1916) considered that the amount of light was not critical. He stated that a fair amount of light was needed to establish new infections at branch ends, not for germination and the penetration of the primary radicle into the host, but for the subsequent development of the aerial parts. Pierce (1905) observed that

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1/ Field work performed or participated in by D. L. Burdick and H. G. Lachmund, former employees of the San Francisco Office of Forest Pathology, U. S. Bureau of Plant Industry.

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the radicle of a germinated seed was always negatively phototropic to a marked degree.

That the true role of light may not have been accurately interpreted by some of these investigators is suggested by two sets of observations of the dwarfmistletoe Arceuthobium campylopodum Engelm. on Pinus ponderosa Laws. and P. jeffreyi Grev. and Balf. in California. One set was obtained in seeding experiments with this dwarfmistletoe on ponderosa or Jeffrey pines in 1935 at three locations in California.2/ The second set was from an observation plot in second-growth ponderosa pine near Quincy in Plumas County, California, on the Plumas National Forest.3/

In the seeding experiments an ocular estimate was made, after seeding, of the percent of full sunlight received during the season by each host growth segment on which seeds of the parasite were planted. The estimates were for the entire growth segment in each instance and not for a particular site of planting on a segment.

On only two plots, one on the Plumas National Forest and one on the Lassen National Forest, were sufficient infections obtained from the seedings to permit a satisfactory comparison of the ratings. On both, the arithmetic mean percent of estimated direct sunlight received was significantly higher for growth segments on which no infections became established than for those on which establishment occurred (table 1). On a third plot, Stanislaus No. 1, the number of infections obtained was too small for a satisfactory comparison, but the means of estimated direct sunlight received differed in the same direction; a mean of 42.3 percent for 91 growth segments on which no infection resulted as against 33.3 percent for 3 segments that became infected.

The results of these estimates suggest that partial sunlight is more favorable to the establishment of dwarfmistletoe on the host than relatively full or continuous sunshine. Infection can occur under comparatively minimal amounts of sunlight. Of segments rated as receiving 10 percent or less of direct sunlight and still living 4 years later on the Lassen and Plumas plots, 6 became infected and 9 did not. Establishment under these shaded conditions was at a ratio of about 2-1/2 times that for infection on the plots as a whole.

2/ Wagener, Willis W. The incubation period for the dwarfmistletoe Arceuthobium campylopodum Engelm. on ponderosa and Jeffrey pines in California as indicated by experimental seeding. Ms. submitted to Forest Science. 1960.

3/ Wagener, Willis W. Forty years of dwarfmistletoe on a ponderosa pine plot near Quincy, California. 15 pp. U. S. Forest Serv. Pacific Southwest Forest and Range Expt. Sta. Feb. 14, 1961. (Processed.)

Table 1.--Dwarfmistletoe establishment and percent of estimated direct sunlight received by host growth segments

Plot	Growth segments		Estimated direct sunlight received		t
	Noninfected	Infected	Noninfected	Infected	
	Number	Number	Mean percent	Mean percent	
Plumas No. 1 [1]	161	15	44.8	30.7	[2] 2.51
Lassen No. 2 [3]	125	32	33.7	28.3	[2] 1.95

1/ Located near the former headquarters of the Feather River Experimental Forest, Pacific Southwest Forest and Range Experiment Station.

2/ Significant at the 5 percent probability level by t test.

3/ Located about 8 miles west of Susanville, California.

The second set of observations was taken on Plot 3 of the Quincy Junction dwarfmistletoe plot series established in 1920. Notes on age, relative size of swelling, vigor of host part, and the amount of light received were taken on 151 Arceuthobium campylopodum infections with long, robust vegetative shoots. Average minimum shoot length was about 8 cm.

Grading was into three to four classes and was done by ocular estimate. When these were segregated (table 2), more than half were in the young infection class; 72 percent were borne on host parts rated as thrifty or vigorous; and 77 percent were rated as receiving medium or poor light. The "poor light" class is the largest numerically, with 41 percent of the total infections.

From these results, and those from the experimental seeding, one would hardly reach the conclusions formerly expressed concerning the beneficial effect of high light intensity on the development of the parasite. If high light intensity is beneficial to the dwarfmistletoe, it must be exerted indirectly through the effect on the host tree or through the general influence on site conditions. Results of these California studies suggest that the role of light in the establishment and development of dwarfmistletoe warrants reappraisal through controlled experiments. To help meet this need, an investigation of light requirements for the germination and establishment of one form of Arceuthobium campylopodum is in progress under a cooperative project between the Pacific Southwest Forest and Range Experiment Station and the Department of Plant Pathology, University of California.

Table 2.--Number of dwarfmistletoe infections with robust shoots, by estimated light received and by ratings for age of of infection, relative size of swelling, and vigor of host part on which the infection occurred

Estimated intensity of light received	Age of infection			Size of swelling			Vigor of host part				Total number of infections	Percent of total
	Yng.	Med.	Old	Sm.	Med.	Lge.	Poor	Mod.	Thr.	Vig.		
Strong	2	1	0	1	0	2	0	0	0	3	3	2
Good	15	14	3	8	15	9	0	6	18	8	32	21
Medium	29	19	7	23	21	11	3	16	28	8	55	36
Poor	37	17	7	25	23	13	2	16	23	20	61	41
Total number	83	51	17	57	59	35	5	38	69	39	151	100
Percent of total	55	34	11	38	39	23	3	25	46	26	--	100

Legend:
Yng. = Young
Med. = Medium
Sm. = Small
Lge. = Large
Mod. = Moderate
Thr. = Thrifty
Vig. = Vigorous

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